

SECRET

Sub A!

An optical device comprising:
 a first I/O waveguide coupled to a first collimator assembly;
 a second I/O waveguide coupled to a second collimator assembly;
 a third I/O waveguide coupled to a third collimator assembly;
 a single-side-pass filter between the first and second I/O waveguides;
 a single-side-pass filter between the second and third I/O waveguides;
 a second wavelength beam splitter between the first and second I/O waveguides;
 a third wavelength beam splitter between the second and third I/O waveguides.

The optical device further comprising:
 a first collimator assembly comprising a lens, a single-side-pass filter, a first waveguide optically coupled to the lens, and a single-side-pass filter reflecting the first waveguide through the second waveguide.

The optical device further comprising:
 a second collimator assembly comprising a lens, a single-side-pass filter and a first waveguide optically coupled to the lens and the second wavelength beam splitter in the first waveguide.

The optical device further comprising:
 a third collimator assembly comprising a lens, a single-side-pass filter and a first waveguide optically coupled to the lens and the third wavelength beam splitter in the second waveguide.

The optical device further comprising:
 a fourth collimator assembly comprising a lens, a single-side-pass filter and a first waveguide optically coupled to the lens and the third wavelength beam splitter in the second waveguide.

wavelengths;

440

4424

Suba₂¹
3 th
4 fil

the first single-side-pass filter and a first waveguide, wherein the first single-side-pass filter passes the second wavelength between the first I/O waveguide and the third I/O waveguide through the first waveguide of the second collimator assembly.

- 1
- 2
- 3
- 4
- 5
- 6

optically coupled to the second waveguide of the first collimator assembly; and a second waveguide;

and

7 a second single-side-pass filter optically coupled to the GRIN lens of the
8 third collimator assembly and the GRIN lens of the fourth collimator assembly, wherein
9 the second single-side-pass filter reflects a third wavelength of the plurality of wavelengths
10 between the first waveguide of the third collimator assembly and the second waveguide of
11 the third collimator assembly and passes the first frequency between the first waveguide of
12 the third collimator assembly and the first waveguide of the fourth collimator assembly.

1 5. The optical device of claim 4 further comprising:
2 a fifth collimator assembly comprising a GRIN lens, a first waveguide
3 optically coupled to the first waveguide of the second collimator assembly; and a second
4 waveguide;
5 a sixth collimator assembly comprising a GRIN lens and a first waveguide;
6 and
7 a third single-side-pass filter optically coupled to the GRIN lens of the fifth
8 collimator assembly and the GRIN lens of the sixth collimator assembly, wherein the third
9 single-side-pass filter reflects a fourth frequency of the plurality of optical signals between
10 the first waveguide of the fifth collimator assembly and the second waveguide of the fifth
11 collimator assembly and passes the second wavelength between the first waveguide of the
12 fifth collimator assembly and the waveguide of the sixth collimator assembly.

1 6. The optical device of claim 2 wherein the first collimator assembly
2 and the second collimator assembly and the first single-side-pass filter are an integrated
3 assembly.

1 7. The optical device of claim 1 wherein the first single-side-pass filter
2 is a long-pass filter.

1 8. The optical device of claim 1 wherein the first single-side-pass filter
2 is a short-pass filter.

1 9. The optical device of claim 5 wherein specified wavelengths for the
2 first, second, and third single-side-pass filters are separated by about 25.6 nanometers.

1 10. The optical device of claim 5 wherein a specified wavelength of the
2 first single-side-pass filter is about 1550.02 nanometers, a specified wavelength of the
3 second single-side-pass filter is about 1524.38 nanometers, and a specified wavelength of
4 the third single side-pass filter is about 1575.62 nanometers.

1 11. An optical system including an optical device as described in
2 claim 1.

1 12. The optical device of claim 1 further comprising:
2 a fourth I/O waveguide carrying a third wavelength of the plurality of
3 wavelengths; and
4 a second single-side-pass filter, wherein the second single-side-pass filter
5 reflects the third wavelength between the first I/O waveguide and the fourth I/O waveguide
6 and passes the second wavelength between the first I/O waveguide and the third I/O
7 waveguide.

1 13. The optical device of claim 9 further comprising:
2 a fifth I/O waveguide carrying a fourth wavelength of the plurality of
3 wavelengths; and
4 a second single-side-pass filter, wherein the second single-side-pass filter
5 reflects the fourth wavelength between the first I/O waveguide and the fifth I/O waveguide
6 and passes the second wavelength between the first I/O waveguide and the third I/O
7 waveguide.

1 14. The optical device of claim 13 wherein the first, second and third
2 single-side-pass filters are separated by about 25.6 nanometers.

1 15. The optical device of claim 1 further comprising:
2 a first GRIN lens optically coupled between first I/O waveguide and the
3 first single-side-pass filter; and
4 a second GRIN lens optically coupled between the third I/O waveguide and
5 the first single-side-pass filter.

